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COMMUNICABLE DISEASE CENTER

TECHNICAL DEVELOPMENT DIVISION

SAVANNAH, GEORGIA

SUMMARY OF ACTIVITIES NO. 8

FOURTH QUARTER

OCTOBER, NOVEMBER, AND DECEMBER

1946

U. S. PUBLIC HEALTH SERVICE

RESTRICTED

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INSECTICIDE INVESTIGATIONS

R. W. Fay, W. C. Baker, R. H. McCauley, H. I. Scudder[1/]

Adult Mosquito Control Studies (Laboratory)

During the past year several candidate insecticides have been tested and evaluated in the laboratory using A. *quadrimaculatus* adult female mosquitoes as the test insects. Candidate insecticides have been tested for their residual properties only, and have been formulated with solvents suitable for premise application and in such concentration that residues of approximately 100 and 200 mg. of toxicant per sq. ft. could be obtained. Several chemicals gave excellent immediate control of the mosquitoes but retained little residual action. Only the more promising chemicals are presented in table 1.

As shown in table 1, the benzene hexachloride[2/] containing 30 percent of the gamma isomer was somewhat superior to that containing only 10 percent gamma isomer. All samples of benzene hexachloride submitted, however, were characterized by a very penetrating, disagreeable and

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1/ Resigned December 1, 1946

2/ In accordance with the decision reached by the Interdepartmental Committee on Pest Control at their fifth meeting, held on November 20, 1946, the common name "benzene hexachloride" will hence forth be used to refer to the technical grade of hexachloro-cyclohexane, $C_6H_6Cl_6$, consisting of a mixture of isomers, usually from ten to thirty percent of the gamma isomer. It may at times be abbreviated as "BHC." It has also been known in the past as "666." The most active ingredient as now known, sometimes referred to as "Gammexane" will be referred to as "the gamma isomer of benzene hexachloride," or sometimes for convenience simply as "gamma isomer."

Table 1. Twenty-four hour mortality (percent) of adult female A. quadrimaculatus mosquitoes after 60 minute exposures to various insecticidal residues two to thirty-six weeks after spray application.

Insecticide	Solvent	Dosage mg/ft.²	Time After Spraying (weeks)									
			2	4	6	8	12	16	20	24	32	36
BHC 30% g*	Xylene	100**	100	--	100	94	--	59	--	23	6	5
BHC 30% g	Xylene	200**	100	--	97.5	94	--	97	--	72	--	31
BHC 10% g	Xylene	200**	100	--	99	97	--	91	--	38	--	37
Neocid BA-50	Water	200	45	70	--	92	92	--	--	--	90	84
DDD - 5%	Kerosene	200	97	90	--	88	--	80	--	--	--	--
DDD - 5%	Kerosene	100	91	90	--	57	--	33	--	--	38	34
DDD - 5%	Xylene	200	89	--	--	72	--	64	--	--	--	--
Deenate 25-W	Water	200	--	81	--	--	--	--	64	71	--	--
Gesarol DT-50	Water	200	--	39	--	--	--	--	33	28	--	--
Deenate 50-W	Water	200	--	95	--	--	--	--	72	68	--	--
Genitox 5-50	Water	200	--	84	--	--	--	--	62	53	--	--
Dupont 90%	Water	200	--	91	--	--	--	--	87	90	--	--
"3956" 25%	Water	200	--	--	--	93	77	70	71	47	--	--
Tech."1068"	Kerosene	200	--	--	--	90	60	75	66	60	--	--
Dycoro 25%	Water	200	92	98	96	91	87	--	--	--	--	--
Dycoro 35%	Water	200	98	98	98	97	97	--	--	--	--	--
Tech. "3956"	Xylene	200	--	--	--	66	--	27	19	18	--	--
Tech. "1068"	Xylene	100	--	--	--	35	--	16	9	5	--	--
Conc. "1068"	Kerosene	200	--	--	--	88	74	64	60	53	--	--

*Benzene hexachloride containing 30 percent gamma isomer. See footnote 2, page 1.

**Technical benzene hexachloride.

persistent odor which would be highly objectionable in premise applications. Although the initial kill was equivalent to that of DDT, benzene hexachloride lost its residual toxicity more rapidly than DDT. There was a considerable portion of insoluble material in the samples submitted which might cause spraying difficulties unless removed by straining the diluted spray mixture.

The Neocid BA-50 is a ready-formulated DDT solution which may be diluted directly with water. It gave results comparable with the standard DDT-xylene-Triton X-100 emulsion spray.

The DDD (Rhothane) was apparently somewhat better in kerosene solution than in xylene solution and during the first 8 weeks at least was equivalent to the standard DDT emulsion but after that time showed more rapid loss of residual toxicity.

There has been considerable variation in the residual toxicity of the various water-wettable DDT samples submitted, the Deenate samples appearing somewhat superior especially the 90 percent DDT powder. As has been previously reported there is considerable variation in the spraying properties of the various water-wettable powders when formulated into finished spray suspensions.

Both the technical and water-wettable forms of "3956" (a chlorinated terpene hydrocarbon manufactured by Hercules Powder Co.) are slow acting and unless improved cannot compare with DDT for residual adult sprays. The "1068" ($C_{10}H_6Cl_8$ manufactured by Velsicol Corp.) residues from kerosene formulations appeared consistently better in residual toxicity than those with xylene as the solvent, but in all cases were not as long lasting in residual properties as the DDT deposits.

The Dycoro DDT byproduct combinations (manufactured by Hercules Powder Co.) showed excellent results and the 35 percent concentrate was somewhat superior to the 25 percent product when applied to give equal concentrations of active ingredient. In more detailed studies it was noted the initial tests of panels gave very low mortalities, but that there was a subsequent sharp rise in toxicity with continued tests. Parkins and Green (Residual Films of DDT, Nature 155 (No. 3944) p. 668 London, 1945) found that crude DDT tended to form supersaturated solutions and that the DDT was not as toxic in this form. It is quite possible that the water-miscible Dycoro concentrates act in a similar manner and do not readily crystallize without agitation such as might be given by insects during the initial tests.

Adult Mosquito Control Studies (Field)

Using the release technique previously reported (in which approximately 500 adult mosquitoes were released in a treated room and in which those knocked down were collected and counted at twenty minute intervals for 4 hours), evaluation of the effectiveness of water-wettable insecticide preparations for adult *Anopheles quadrimaculatus* control in comparison to standard DDT-xylene emulsion can now be given in preliminary form. A series of three rooms was treated with each of the test preparations using a 200 mg. per sq. ft. application of the toxic ingredient. The preparations used contained 5 percent active ingredient and were prepared from 90 percent and 50 percent DDT water-wettable powders, 25 percent "3956" water-wettable powder, and 35 percent DDT-xylene emulsion concentrate.

Four release tests of each room were made at intervals of three, seven, fifteen and twenty-seven weeks after the spray application. The numbers of mosquitoes recovered from each of three rooms were weighted in proportion to the square root of the total number released in each. The percentage knockdown for each test was an average of these three weighted figures.

In table 2 comparisons are best drawn from figures showing the relative number of minutes required for a 50 percent knockdown of the released mosquitoes. This was estimated by interpolating between counts made at 20 minute intervals. By this criterion the 90 percent DDT water-wettable mixture has approximately the same effectiveness as the DDT-xylene emulsion. The 50 percent DDT water-wettable powder, however, was considerably less rapid in action than either of the former. This difference was not only indicated in the initial tests, but after 25 weeks the differential had increased to nearly an hour. The 25 percent "3956" water-wettable powder proved to be extremely slow acting. Even in the first tests a 50 percent knockdown required 30 minutes more than the 50 percent DDT water-wettable powder at the age of 26 weeks. At 24 weeks after application of "3956" a 50 percent knockdown was not obtained during the four-hour test period.

Table 2. Comparative time periods required for different percentage of knockdown of adult female *A. quadrimaculatus* mosquitoes when released in test rooms treated with various insecticide preparations. Figures derived from weighted averages of test data from three rooms each.

Insecticide, 200 mg. per square foot.	DDT				DDT				DDT				"3956"			
Preparation	Xylene Emulsion				90% Water Wettable				50% Water Wettable				25% Water Wettable			
Test Number	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Average Age (days)	22.6	49.6	103	191.3	19	64.6	124.3	179.3	26	79	126.6	182.3	23	87	132.3	170
Age Range (days)	18-24	45-56	99-108	183-198	15-27	64-65	115-140	171-184	21-29	65-88	109-136	165-183	21-24	86-88	130-134	169-171
Period (minutes) of greatest KD	40-60	40-60	60-80	80-100	60-80	40-60	100-120	60-80	60-80	60-80	160-180	100-120	180-200	200-220	220-240	200-220
Number of Minutes for 50% KD*	63	70	83	118	80	69	129	111	95	119	192	168	198	200	214	240+
Number of Minutes for 100% KD	240	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+	240+

* Interpolated from counts made at 20-minute intervals.

The cumulative percent of knockdown at the end of each hour of the test period (table 3) reveals essentially the same results. The hourly knockdown by the 90-percent-DDT water-wettable-powder residue compares favorably with that of DDT-xylene standard emulsion. The knockdown obtained with the 50-percent-DDT water-wettable powder was decidedly inferior, particularly the four-hour knockdown of the third and fourth series of releases. The 25-percent-"3956" powder acted much more slowly than even the 50-percent-DDT powder and almost completely lost is effectiveness after 24 weeks, having knocked down only 6.8 percent of the mosquitoes in 4 hours.

The difference in effectiveness of DDT when combined in water-wettable powders with different amounts of inactive ingredients presents an important problem. It may be that the difference in effectiveness is due to mechanical masking of the toxicant by the inactive carrier. If this is true those mixtures containing the lowest proportion of active ingredients can be expected to be less effective, but further investigation of this point is needed. "3956" has been shown in the preceding "Summary of Activities" (No. 7) to be very slow acting in comparison with other residual insecticides in the technical form and this holds true for the water-wettable-powder form also. If a mechanical factor is present as suggested above this powder preparation has an additional disadvantage.

As a matter of interest in the durability of DDT residues applied in the field, a few tests were made in rooms which had been treated

Table 3. Cumulative percentages of knockdown of adult female *A. quadrimaculatus* mosquitoes at the end of one-hour periods after exposure to residual deposits of various insecticide preparations ranging in age from 3 weeks to 6 months. Results are weighted averages of test data from three rooms each.

Insecticide, 200 mg. per square foot.	DDT				DDT				DDT				"3956"			
Preparation	5% DDT-xylene-Triton X-100 Emulsion				5% Suspension from 90% Water-wettable Powder				5% Suspension from 50% Water-wettable Powder				5% Suspension from 25% Water-wettable Powder			
Test Number*	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1st hour	45.6	36.2	29.7	9.9	19.1	42.3	2.6	13.0	12.1	13.0	1.9	8.6	.8	1.4	1.3	2.3
2nd hour	90.5	85.8	75.2	51.3	85.2	83.2	42.8	57.0	71.6	50.7	13.4	30.6	5.1	11.0	5.4	3.7
3rd hour	97.9	96.2	91.9	83.4	97.0	96.1	80.4	86.4	93.0	80.7	45.4	54.9	37.7	38.6	33.2	5.0
4th hour	100	99.1	98.1	94.3	99.6	99.6	96.9	95.7	99.0	93.4	71.8	77.2	71.7	74.0	64.1	6.8
Percent Remaining	0	.6	1.4	5.6	.2	.3	2.6	4.2	.9	6.6	27.9	22.4	28.0	25.9	35.9	93.3

*Age of test 1 was about three weeks; test 2, about seven weeks; test 3, about fifteen weeks; and test 4, about twenty-seven weeks.

during the summer of 1944. Three rooms, located in an abandoned building, had received respectively a 200 mg. DDT per sq. ft. treatment applied as a 5 percent DDT kerosene solution, a 200 mg. DDT per sq. ft. treatment applied as standard 5 percent DDT-xylene-Triton X-100 emulsion and an 800 mg. DDT per sq. ft. treatment applied as a xylene solution. Release tests have been run at various intervals following application using *A. quadrimaculatus* mosquitoes, wild, mixed or insectary-reared as indicated (table 4).

At the time of the 1946 tests the DDT residual deposits were more than two years old. Some damage to the surfaces within the rooms due to age and vandalism was evident. The only important variation in the present and previous techniques involved the method of counting the mosquitoes affected during the first few hours of the test. In earlier releases the insects were left in the room overnight, picked up and counted in the morning, while in the present tests they were aspirated from the walls and ceiling and counted at the end of four hours. It is believed that a greater number of test mosquitoes is lost by the former method from the activity of other insects and spiders.

The most interesting indication of the latest test is that DDT retains a significant measure of effectiveness on sheltered, shaded, dry surfaces for periods well in excess of two years. The 800 mg. DDT per sq. ft. treatment appeared to have remained better than the 200 mg. DDT per sq. ft. deposit. The emulsion applications acted more rapidly than the kerosene solution applications. A check release was made in

Table 4. Comparative knockdown of *A. quadrimaculatus* in three test rooms with various DDT residues at ages up to 127 weeks, with sources of mosquitoes and mean temperatures for each test.

Formulation	mg/ft.^{2}	Age of Treatment (weeks)	Source of *Anopheles quadrimaculatus*	Average Temperature	Minutes required for 50% KD	Minutes required for 85% KD
DDT Kerosene Sol. (Rm. 4)	200	22	wild	79°F	102	170
		24	mixed*	68	85	125
		48	insectary	75	85	130
		52	insectary	69	125	175
		62	insectary	82	140	203
		72	insectary	88	93	150
		76	insectary	63	180	285
		127	insectary*	67	180	240+
DDT Xylene Emul. (Rm. 5)	200	8	wild	83	65	120
		12	insectary*	63	68	95
		33	insectary	76	80	125
		38	insectary	72	90	155
		49	insectary	86	95	155
		56	insectary	88	92	135
		62	insectary	66	125	172
		111	insectary*	68	120	165
DDT Xylene Sol. (Rm. 6)	800	6	wild*	77	65	103
		8	mixed*	65	80	122
		10	insectary	71	57	80
		31	insectary	76	80	100
		35	insectary	70	85	105
		46	insectary	82	75	117
		55	insectary	84	92	125
		63	insectary	67	130	235
		108	insectary*	84	100	105

* Females only.

an untreated room adjacent to the test rooms and after more than four hours only one mosquito had fallen.

Coincident with these studies the effectiveness of the old residual deposits were tested against the house fly, M. domestica. Five hundred insectary-reared flies were released in the rooms having the 800 mg. DDT per sq. ft. and the 200 mg. DDT per sq. ft. deposits from a standard DDT-xylene-Triton X-100 emulsion application. The results in comparison to a more recently treated room are given in table 5.

Table 5. Comparative Knockdown of M. domestica from DDT residues of various ages.

Test Room No.	Treatment	Age of Residue (weeks)	Average Test Temperature	Minutes for 50% Knockdown	Minutes for 100% Knockdown
Rm. 6	800 mg./ sq. ft. DDT- Kerosene Solution	112	66°F	32	90
		118	70°F	41	120
Rm. 5	200 mg./ sq. ft. DDT- (Xylene Emulsion)	112	66°F	46	240
		118	70°F	99	260
Rm. 7	200 mg./ sq. ft. DDT- (Xylene Emulsion)	4	80°F	36	120
		12	80°F	45	100
		20	71°F	46	140

House Fly Control Studies (Laboratory)

In view of the use of DDT-xylene emulsion and water-wettable DDT preparations for outside residual applications in the control of blow flies, it was deemed advisable to check the relative resistance of the different mixtures to weathering conditions. Panels were prepared in the laboratory containing residues of 200 mg. DDT per sq. ft. from a 5 percent DDT-xylene-Triton X-100 emulsion and from a 5 percent DDT suspension made with 50 percent water-wettable DDT powder. Sets of panels were exposed to direct sunlight only, others to rain and shade only, and others to a general combination of all weather conditions. Fifteen-minute exposures of insectary-reared house flies were made on these panels at various intervals after the initial treatment and the results are shown in table 6.

Table 6. Twenty-four hour mortalities of adult female *M. domestica* after 15 minute exposures to 200 mg. DDT per sq. ft. residues from standard DDT xylene emulsion and water-wettable DDT suspension exposed to varying weather conditions.

Weather Condition	Type of DDT	Time after spraying (weeks)						
		1	2	4	6	10	14	16
Rain and Shade	Water-wettable	100	100	97	92	89	32	11
	Emulsion	96	96	94	93	90	76	44
Sun Only	Water-wettable	74	74	78	86	90	77	59
	Emulsion	99	99	99	100	98	100	87
Sun and Rain	Water-wettable	100	100	87	63	3	2	-
	Emulsion	99	99	98	79	70	37	17

From the results as shown it appears that the emulsion residues are a little longer lasting in their residual effectiveness. In both types of deposits the action of the rain seems to be a greater factor than the action of the sun in the loss of residual activity.

Leaves from trees adjacent to a city dump were given a water-wettable DDT application in the control of blow flies. Two months after the final application the leaves were used to cover test panels. Two sets of panels were fashioned, one using those leaves which showed traces of white discoloration from the treatment and for the other set those leaves which had no visible traces of treatment remaining. The leaves showing traces of the treatment either had the upper surface in a protected location or retained the traces on their lower surfaces. Laboratory tests with _M. domestica_ and 15-minute exposure periods showed no twenty-four-hour mortalities from the leaves without visible deposits and 36 percent from the leaves with white deposits. Thirty-minute exposures of _M. domestica_ gave 0.0 and 86 percent mortalities respectively for leaves without and with visible DDT deposits. From these results, it is apparent that the protected surfaces of leaves would still be lethal to insects contacting them, but the presence of the non-lethal exposed surfaces would greatly decrease the efficiency of the area control.

Hookworm Investigations (Laboratory)

Studies have been made to work out techniques for culturing hookworm larvae for laboratory and field experiments with recently developed soil fumigants. In preliminary work the dog hookworm has been used because of its ready availability. Feces have been collected from the local dog pound and ova extracted by salt flotation and centrifugalization. Larvae have been reared to the infective stage and recovered from soil infested in the laboratory by the use of the Baermann technique as modified by Cort (Cort, W.W., Ackert, J. E., Augustine, D. L. and Payne, F. K. Investigations on the control of hookworm disease II. The description of an apparatus for isolating infective hookworm larvae from the soil. Amer. Journ. Hyg. 1922, Vol. 2, No. 1 p. 1-16). Methods are being devised to evaluate the infestation of a given sample of soil by a sampling technique. Larvae recovered are counted volumetrically.

EFFECTS OF DDT MOSQUITO LARVICIDING ON WILDLIFE

C. M. Tarzwell

Field studies at the Savannah River Refuge on the effects of DDT sprays and aerosols applied by airplane were concluded the last of October. During the course of the study, 1800 square-foot surface samples and 720 bottom samples were taken from 2 check and 4 treated areas. Samples were taken before treatment, about midseason and at the end of treatment. Fish population studies were made before treatment in two of the areas, after treatment in 3 areas and in a check area. Observations by boat were made on all ponds every week after each treatment to detect any kill of fish or insects. Some dead insects, especially Diptera, Coleoptera and Hemiptera, were found in the treated ponds. Few dead fish were noted and the fish-population studies indicated that there had been no reduction in the fish population during the first season of treatment.

Studies of the effects on fish, in deep water (3 to 10 feet) of the larvicidal use of DDT, DDD, "1068" and "3956" were concluded the last of November. It was found that the character of the pond greatly influenced any action of DDT on fish. The pond routinely treated with 0.1 pound of DDT per acre had considerable surface vegetation and organic matter and there was no detected kill of fish over a period of 14 treatments. Further, a fish-population study at the end of treatment demonstrated a large fish population. However, in a deeper pond without surface vegetation, fish kills occurred with routine DDT treatments at the rate of 0.05 pound per acre. The kills became prominent after the 13th treatment and the fish-population study indicated a reduced population. No kills were noted at dosages of 0.025 pound per acre.

Routine treatment with DDD at 0.1 pound per acre resulted in fish kills and a reduction of the population. No kills or reductions were noted at dosages of 0.05 and 0.025 pound per acre. The pond receiving 0.05 pound DDD per acre was almost identical to the one receiving 0.05 pound of DDT per acre.

Fourteen routine treatments at 0.1 pound per acre with "1068" reduced the fish population to a considerable extent. No kills or reductions were noted at routine dosages with 0.05 and 0.025 pound per acre.

Tests with "3956" indicate it to be an effective fish poison at dosages of 0.1 pound per acre.

EQUIPMENT DEVELOPMENT

H. Stierli and C. Crumley

The need for a device to replace the rubber tip in the shut-off valve pin on Hudson Perfection shut-off valves was presented at the State District CDC Conference held in Atlanta November 20-22, 1946.

Initially an attempt was made to roll out the cup edges of the brass shut-off valve pin, insert the rubber tip by hand, and then roll the brass tight against the rubber tip. This attempt proved unsuccessful because the brass failed each time it was rolled out. Small cracks appeared on the cup edge of the pin.

The possibility of forcing the rubber tip through a long cone-shaped hole to reduce its size to the diameter of the cup in the brass pin was next investigated. For this device, it was necessary that the diameter of the plunger be no larger than the smallest diameter of the cone. The resistance of the rubber tip to slide through the cone caused the rubber to roll back around the plunger and fail. It was obvious that the plunger would have to be the same diameter as the hole. Therefore, the principle of forcing the rubber tip through a short restricted opening as shown in plate 1 was tested and was found to give satisfactory results. The plunger is the same size as the hole so that the rubber tip can move only in the direction of the small tapered opening and the tendency to roll back is eliminated.

The parts for the tool as shown in plate 1, view A were then fabricated and assembled. Essentially, it consists of the following: (1) two-handle assembly, (2) cylinder assembly, (3) plunger, and (4) sleeve. The two-handle assembly is pin connected and works on the plier principle. The sleeve serves two functions: To hold the brass pin against the hole and to hold the cylinder halves together in the closed position. It is free to rotate in the plane of the handles as is the plunger and cylinder. The plunger is free to slide in the cylinder. A positive stop is incorporated to prevent the plunger from entering the tapered area of the cylinder and thereby damaging it. The cylinder assembly is hinged as shown in plate 1 to allow placement of the rubber tip in the cylinder without removing the plunger, and to provide for the removal of the completed pin after the tip is inserted.

The operation can best be described in a series of steps:

(1) Place the tool in an open position as in plate 1, view A.

(2) Place the shut-off valve pin in the sleeve.

(3) Place the rubber tip in the cylinder between the plunger and tapered hole and close the cylinder.

(4) Rotate the plunger and sleeve until they are in line and insert the cylinder assembly in the sleeve as in view B.

(5) Squeeze on the handles until the plunger is felt to reach the bottom of the cylinder, as in view C.

(6) Open the handles, and pin is ready to be removed as in view D.

The tool is relatively simple and efficient. All adjustments have been eliminated and there are no loose parts. A squeeze on the handles inserts the tip in the pin.

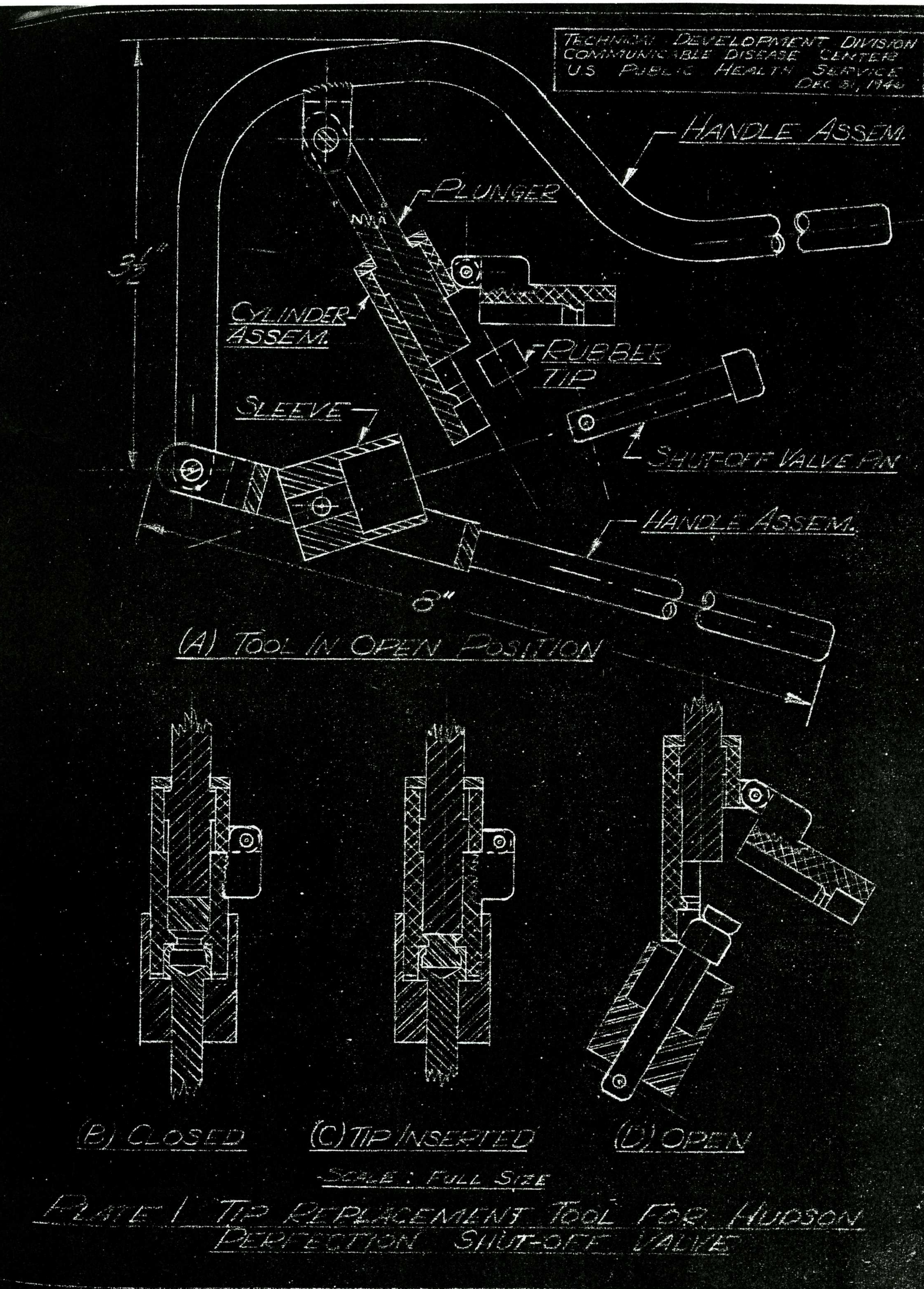

PLATE I. TIP REPLACEMENT TOOL FOR HUDSON PERFECTION SHUT-OFF VALVE

Evaluation of Commercial Battery-operated Air Compressor

A Dapco Model 126 battery-operated air compressor was tested for potential use in charging four-gallon spray cans on the Extended Malaria Control Program.

The Dapco Model 126 compressor is of the diaphragm type with driving plate and connecting rod driven by a counterweighted eccentric mounted on the shaft of a 6-volt electric motor. No lubrication is required as the eccentric is fitted with a sealed grease-packed ball bearing. The compressor head and housing are finned to carry away heat of compression. The manufacturer's rating of this unit is 3 1/2 cfm free air capacity, approximately 1 1/4 cfm at 80 psi pressure, and a maximum pressure of 120 psi. A steel box 9 1/4" x 9 1/4" x 15 1/2" is furnished with the unit for mounting on the running board or elsewhere on a truck or other vehicle. The compressor is completely equipped with 15 feet of air hose, a dual-foot combination tire chuck, an air gauge, and 9 feet of battery cable. The motor-starting switch is built in the air chuck so that the compressor runs only while using the air chuck.

As a preliminary test, the air compressor was taken out of the metal box and mounted on a bench for connection to a fully-charged 100-ampere-hour3/ automobile battery. The motor-starting switch was found to be faulty but was repaired. The compressor was observed to operate with much vibration and was found to be quite noisy.

3/ Rating based on a standard 20-hour test.

After completion of about one minute of satisfactory operation with free air discharge, the compressor was subjected to several conditions which are likely to be met in the field (see table 7). Since the normal liquid charge of the four-gallon spray can is 1 3/4 gallons, an air volume of 2 1/4 gallons remains which must be charged to 55 psi pressure. Therefore, the time to fill a spray can with air was first observed and found to be approximately 35 seconds with the compressor connected to the fully charged battery. The next four cans (9 gallons total air volume) required 2 minutes 39 seconds, an average of about 40 seconds per can. As seen from the table, the specific gravity of the 100 A-H battery was reduced from 1.28 to 1.265 during the filling of the first five spray cans.

As attempts might be made to employ the compressor to charge auxiliary storage tanks up to 120 psi pressure, a 9-gallon tank was charged in steps as follows: 0 to 60 psi; 60 to 95 psi; 95 to 110 psi; and 110 to 120 psi. Table 7 shows the operation time required for each step and the discharge of the battery for such use. It should be noted that the compressor output was markedly reduced at pressures above 60 psi and extremely low at pressure above 95 psi. Furthermore, the motor and compressor became hot during the final step of operation, probably due to a combination of long uninterrupted use and the high discharge pressure.

The compressor was further operated until difficulty was encountered in starting the electric motor and the rotative speed became noticeably slower. After 25 minutes of use, the battery specific gravity had been

Table 7. Preliminary operation test data obtained on Dapco Model 126 air compressor unit.

Volume of Air in Tank (Gal.)	Pressure Increase (psi)	Compressor Operation Time		Battery Specific Gravity*		Remarks
		Min.	Sec.	Initial	Final	
2 1/4	0-55		35	1.28	----	
9	0-55	2	39	----	1.265	
9	0-60	2	54	1.265	1.255	
9	60-95	4	3	1.255	1.24	
9	95-110	3	6	1.24	1.23	
9	110-120	4	38	1.23	1.215	Motor and compressor hot.
2 1/4	0-55		36	1.215	---	
9	0-60	3	12	---	1.20	
2 1/4	0-55		40	1.20	---	
---	---	2	0	----	---	Free discharge
2 1/4	0-55		45	---	1.18	Electric motor turning markedly slower.
Total Operation Time		25	8			

*Average of 3 cells.

reduced to 1.18 (about half charge). Forty-five seconds were required to fill the spray can with the battery at half-charge. Assuming that an average of 40 seconds compressor operation is needed to charge one spray can, about 25 to 40 charges could have been obtained with the battery being discharged from full charge to half charge.

The air-compressor unit was next installed on the running board of a 1/2-ton Dodge "weapons carrier" truck using the same 100 A-H battery. It was found necessary to ground the unit to the chassis of the truck for proper operation, as the running board was inadequately grounded. Table 8 contains the performance data for charging spray cans of four-gallon capacity with the compressor truck-mounted. An equivalent of 48 spray cans was charged in 33 minutes of compressor operation time. The truck engine was run at fast idle 105 minutes with the generator charging an average of approximately 15 amperes. The truck engine was started ten times during the test. As seen from table 8 the specific gravity of the battery was reduced from 1.29 to 1.215. It is estimated that about five hours of truck operation would have been necessary to maintain the battery at full charge.

The air compressor and electric motor became quite hot when the equivalent of 24 spray cans was charged in a forty-minute period (see table 8). However, it is not likely that this many cans would normally be filled in this short interval of time.

Upon completion of about one hour of testing, the compressor was taken apart for inspection. It was noted that the two inlet valve screws

Table 8. Performance data on Dapco Model 126 air compressor unit truck-mounted for charging four gallon spray cans.

Equivalent Number of Spray Cans Charged*	Approximate Compressor Operation Time	Battery Specific Gravity** Initial	Battery Specific Gravity** Final	Truck Engine Time***	Remarks
4	3 min.	1.29	1.275	2 min.	Truck engine "off" during comp. operation.
4	3	1.275	1.265	3	" " " "
4	3	1.265	1.255	4	" " " "
8	6	1.255	1.235	8	" " " "
0	0	1.235	1.235	16	Compressor not operated
0	0	1.235	1.24	16	" " "
8	6	1.24	1.235	16	Truck engine "on" during compressor operation.
8	6	1.235	1.225	8	Compressor and electric motor warm.
8	6	1.225	1.21	16	Compressor and electric motor hot. Starts only with difficulty.
0	0	1.21	1.215	16	
48	33 min.			105 min.	TOTALS

*One spray can equivalent to 2 1/4 gallons of air compressed from 0 to 55 psi pressure.

**Specific gravity average of 3 cells.

***Average charging current approximately 15 amperes.

mounted on the compression plate touched the diaphragm retainer plate when the piston reached the top of its stroke. The two holes recessed in the retainer plate for clearance of the screws had been incorrectly centered. It was necessary to rebore the holes for proper clearance. Furthermore, one of the retainer plate screws had struck the compression plate. The screw head although counter sunk was protruding too much. Hence, the screw head was filed for proper clearance. The bearings and all other parts appeared to be in good condition. After the unit was reassembled, it was run for a few seconds. Although slightly quieter, the performance was unchanged.

As the time required to charge a spray can appeared quite lengthy, a time study was made on the conventional methods of acquiring the necessary pressure. It was found that the use of a supply tank with air pressure of 70 psi pressure or greater enabled charging of a can in 15 seconds as compared with 40 seconds for the battery-operated compressor. Further, with vigorous hand pumping, the same results could be obtained in 50 seconds.

Assuming a three-man crew to employ the battery-operated air compressor, it is estimated about 50 spray-can charges could reasonably be expected. Based on the performance of the Dapco Model 126 unit, either exessive truck-engine operation, or an extra battery with overnight charging of batteries would be required. Generator output might be increased somewhat, as most autos and trucks have a capacity of about 25 amperes and some special army vehicles are equipped with 40-amperecapacity generator systems. However, continued operation of the generator near capacity would endanger the electrical system of the vehicle, causing more frequent break-down and repair than normally experienced. Alteration of the electrical system for greater capacity so that the battery unit might be used, would be costly and unwarranted.

The battery-operated air compressor might be advantageously used for a crew of two men located in a sparsely-settled area requiring three or four hours of driving daily. However, crews of three or more men would be better served by a truck-mounted air compressor with storage tank.

CHEMICAL INVESTIGATIONS

W. R. Schmitz, M. B. Goette, S. L. Resnick, S. B. Richter[4/]

Chemical Deterioration of DDT in Residual Spraying

Tests have been conducted to evaluate more clearly the effect of ultra-violet light and temperatures of approximately 140 and 110 degrees Fahrenheit on deterioration of DDT. All techniques, except those described in this report, have been reported in "Summary of Activities" No. 6 and No. 7.

The effect of ultra-violet light on glass and wood surfaces sprayed with 5 percent DDT in kerosene and 5 percent DDT emulsion was previously reported in "Summary of Activities" No. 6 and No. 7. The procedure used to obtain those results was to place four 3" by 12" panels in a pasteboard box, approximately 16 1/2" x 16 1/2" x 10 1/2", and insert an ultra-violet light of the General Electric Company BH4 dark-light type. All other light was shut out and there was no air circulation in the box. After long periods of exposure, the temperature reached as high as 113 degrees Fahrenheit. The total exposure was for 248 hours or 31 eight-hour days. The ultra-violet light was not operated continuously, but in 8 hour intervals. The results obtained are summarized in table 9.

Since the temperature on occasions reached as high as 113 degrees Fahrenheit, it was thought possible that some of the DDT loss was due to the heat rather than to the ultra-violet light. In order to keep

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4/ Transferred December 1, 1946.

Table 9. Recovery of DDT after exposure to ultra-violet light.

Description of Tests	5% DDT in Kerosene			5% DDT Emulsion		
	Glass	Paper	Wood	Glass	Paper	Wood
1. Control panels kept at room temperature and in dark for one month.	63%	85%	86%	97%	97%	90%
2. Exposed to 248 hours of ultra-violet light in box. Temperature not controlled; up to 113°F.	41%	--	46%	65%	--	77%
3. Exposed to 248 hours of ultra-violet light in refrigerator. Temperature up to 77°F.	76%	108%	66%	79%	104%	91%

Note: Percentages are based on the amount of DDT theoretically applied.

the temperature caused by the ultra-violet light down to room temperature or below, the ultra-violet light unit was connected inside a refrigerator. Duplicate panels of 5 percent DDT in kerosene and 5-percent-DDT emulsion on glass, paper, and wood surfaces were prepared and placed inside the refrigerator. The temperature, during the exposure period of 248 hours, did not reach any higher than 77 degrees Fahrenheit. The results obtained (table 9) from the paper surfaces showed no loss as compared to panels kept at room temperature in the dark for one month. Only the kerosene-wood panels and the emulsion-glass panels showed any loss of DDT.

Although rigorous proof is still lacking, it appears that the heat produced by sunlight or ultra-violet light is of more importance in causing loss of DDT than any catalytic effect of the rays.

It was reported in "Summary of Activities" No. 6 that temperatures of approximately 140 degrees Fahrenheit caused considerable loss of DDT. Whether this loss of DDT was due to decomposition or volatilization or both, has not been established. In a preliminary test, a 6" x 15" x 1" water-cooled steel condenser was placed inside the oven at approximately 3/4 of an inch above a 3" x 12" glass panel. Water was continuously circulated so that a flat cool surface was directly above the panel. When kept at approximately 140 degrees Fahrenheit for one week, as much as 39 percent of the 50 milligrams of DDT, applied as 5 percent DDT in kerosene solution, was recovered from the condenser. About 5 percent of the DDT remained on the panel and about 56 percent of the DDT was unaccounted for. Further work is underway to improve the design of the experiment and to find out what happens to the DDT that is lost.

A study has also been undertaken to determine the rate of loss of DDT at temperatures of approximately 140 degrees Fahrenheit and 110 degrees Fahrenheit. Due to the capacity of the oven and the non-uniformity of the temperature, it was necessary to use glass panels smaller than 3" x 12" and to use duplicate panels. Since the loss of DDT in one week from glass panels at approximately 140 degrees Fahrenheit was previously reported, it was desired to find the loss of DDT that occurred each day during the week. Since kerosene tends to spread easily on glass, only 4.5 milligrams of 5 percent DDT in kerosene solution was applied to a 3" x 6" glass panel, and 14 panels were placed on the same shelf inside the oven. The DDT had completely crystallized previously. Two panels from opposite sides of the oven were removed each day and the DDT remaining on the panel was washed into a beaker with benzene and analyzed for p-p' DDT. The same procedure was followed with the emulsion, except 3" x 3" glass panels were used. The kerosene-glass panels showed a rapid loss of DDT and after the third day, practically 90 percent of the DDT was lost. The emulsion-glass panels showed a more gradual drop and about 50 percent of the DDT was left after 7 days.

The same procedure was followed at temperatures of approximately 110 degrees Fahrenheit. The kerosene-glass panels showed a much slower loss of DDT at this temperature, and after 7 days, only about 30 percent of the DDT had been lost. The emulsion-glass panels showed practically no loss of DDT after 7 days. The irregularities which occurred were doubtless due to the non-uniformity of the temperature within the oven. The data is summarized in table 10.

The type of DDT crystal obtained from a 5-percent-DDT kerosene solution on glass was a fine needle-type crystal, while DDT crystals obtained from a 5-percent emulsion were clumped together in large crystals. An important difference between the two type crystals was the surface area of DDT. Since the loss of DDT at a temperature of approximately 140 degrees Fahrenheit was much greater from kerosene than from the emulsion, it was thought that the difference might be due to the surface area of DDT exposed.

No method has been worked out so that the surface area of DDT crystals could be satisfactorily determined. On glass surface, 5 percent DDT in kerosene spreads evenly over the whole surface, and when crystallized, small crystals of DDT are deposited over the whole surface.

By using glass panels of different sizes and treating each panel with the same amount of DDT, different size DDT crystals could be obtained. With larger glass panels, smaller DDT crystals were obtained, and consequently, more surface area of DDT was exposed. Glass panels having an area of 6, 9, 12, 15 and 18 square inches were each treated with 0.09 ml of 5 percent DDT in kerosene solution or 4.5 milligrams of DDT. These panels were placed in the oven for 3 days at approximately 140 degrees Fahrenheit. There was no difference in the amount of DDT remaining on the 6 and 9 square inch panels, but each of the larger

Table 10. Recovery of DDT on glass surfaces held at temperatures of approximately 140 and 110 degrees Fahrenheit.

Test	Days						
	1	2	3	4	5	6	7
5% DDT in kerosene. 4.5 mg. DDT applied on 3" x 6" glass panels. 140 degrees Fahrenheit	61%	70%	35%	11%	18%	12%	10%
5% DDT emulsion. 4.5 mg. DDT applied on 3" x 3" glass panels. 140 degrees Fahrenheit.	91%	77%	79%	76%	73%	55%	50%
5% DDT in kerosene. 4.5 mg. DDT applied on 3" x 3" glass panels. 110 degrees Fahrenheit.	91%	91%	91%	86%	80%	73%	71%
5% DDT emulsion. 2.5 mg. DDT applied on 1" x 3" glass panels. 110 degrees Fahrenheit.	96%	96%	93%	88%	93%	96%	96%

Note: Percentages are based on the amount of DDT theoretically applied.

panels showed progressively less DDT remaining on the panel. It was concluded that the loss of DDT at temperatures of approximately 140 degrees Fahrenheit increases with the surface area of DDT exposed.

The data is summarized in table 11.

Table 11. Relationship between surface area of DDT crystals and loss of DDT at temperatures of approximately 140 degrees Fahrenheit.

Area of Glass Panel, Sq. in.	6	9	12	15	18
Recovery of DDT	51%	52%	45%	21%	13%

It was reported by Gunther and Tow[5] that picolinic acid and salicylal-amino-guanidine inhibit the catlyzed thermal decomposition of DDT. Tests have been made to determine whether these two compounds would prevent the loss of DDT which occurred at temperatures of approximately 140 and 110 degrees Fahrenheit. Since neither of those two compounds were soluble in kerosene or xylene, it was necessary to dissolve each one in water to the extent of 1 percent. A 5-percent-DDT emulsion was made by diluting 1 part of a 35 percent DDT-xylene concentrate with 6 parts of either one percent picolinic acid in water or one percent salicylal-amino-guanidine in water. Glass panels, 3" x 3", were treated with 4.5 mg DDT from each of the two 5-percent-DDT emulsions containing the inhibitors and placed in the oven at approximately

5/. Science, 104, 203-204 (1946)

140 degrees Fahrenheit for one week. The DDT used was recrystallized DDT and was free from iron. The oven was steel and coated with aluminum paint, and the laboratory air was far from clean. Four panels of each were analyzed and about 50 percent recovery of DDT was obtained from the emulsion containing piccolinic acid and only about 38 percent recovery of DDT was obtained from the emulsion containing salicylal-amino-guanidine.

Thus, under these conditions, piccolinic acid and salicylal-amino-guanidine had no effect in preventing the loss of DDT on glass surfaces at temperatures of approximately 140 degrees Fahrenheit.

Penetration of DDT into Wood Surfaces

Tests have been conducted to determine the effect of concentration of DDT on its penetration into poplar-wood surfaces. The poplar-wood panels were sprayed in the same manner as previously described in "Summary of Activities" No. 6. The wood was well dried and each test was conducted in quadruplicate. Each 3" x 12" wood panel was sprayed with 50 milligrams of DDT, but the volume of liquid ranged from 4 milliliters of 1.25 percent DDT to 0.5 milliliters of 10.0 percent DDT. With both the kerosene solution and the emulsion, recovery of DDT at approximately 0.001 inch of the top surface and at approximately 0.005 inch to 0.007 inch of the top surface was best at the 5-percent concentration. The best recovery of DDT was obtained with the emulsion, but even this showed only about 35 percent within the top 0.001 inch. Thus, it appears that at least 65 percent of the DDT penetrates into dry poplar wood to such a depth that it likely would be unavailable biologically.

Consistently better recovery of DDT was obtained from the emulsion on poplar wood which was green and not thoroughly dry than from dry poplar wood. The opposite was found with DDT kerosene solutions; poorer recovery of DDT was obtained from the green poplar wood than from the dry poplar wood. The condition of the wood affects the penetration of DDT considerably.

The data is summarized in table 12.

A Study of the Formation of DDT Crystals from Various Solvents

It was noticed that solutions of DDT in various solvents crystallized in different forms; therefore, a study was made of the formation of DDT crystals from these solutions as deposited on glass. The solvents used were acetone, benzene, xylene, Solvesso #2, kerosene, Velsicol AR-50, Velsicol NR-70, isophorone, and xylene-water emulsion. In each case drops of 5 percent solutions of DDT in the different solvents were pipetted on glass slides, one inch between each drop, and examined under the microscope over a period of time.

Acetone: Upon falling on the glass slide, the drops spread over the surface, forming a thin film with a diameter of approximately one inch, then broke into small droplets ranging from one to fifty microns in diameter. The outer rim of droplets were the first to crystallize into

Table 12. The effect of concentration of DDT sprays on the penetration of DDT into poplar-wood surfaces.

Depth of Wood Removed	Approx. 0.001"	0.005"-0.007"
Concentration of DDT	Recovery of DDT	
A. Dry Poplar Wood		
1. 1.25% DDT Emulsion	22%	47%
2. 2.5 % DDT Emulsion	32%	59%
3. 5.0 % DDT Emulsion	35%	73%
4. 7.0 % DDT Emulsion	17%	27%
5. 10.0 % DDT Emulsion	15%	27%
6. 1.25% DDT in Kerosene	29%	33%
7. 2.5 % DDT in Kerosene	27%	53%
8. 5.0 % DDT in Kerosene	32%	57%
B. Green Poplar Wood		
1. 1.25% DDT Emulsion	30%	64%
2. 2.5 % DDT Emulsion	40%	64%
3. 5.0 % DDT Emulsion	46%	86%
4. 1.25% DDT in Kerosene	5%	18%
5. 2.5 % DDT in Kerosene	10%	20%
6. 5.0 % DDT in Kerosene	10%	29%

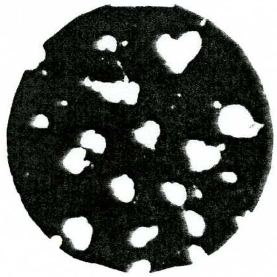
small irregular clumps (plate 2a), with less than fifty percent of the droplets having crystallized after 24 hours. The balance of the droplets were extremely slow in forming crystals as droplets were still visible after 15 days.

Benzene: Unlike the acetone, the drops did not spread to any extent, but formed a small globule which broke within an hour into a number of small droplets ranging from 600 to 1000 microns in diameter. These crystallized into irregular clumps (plate 2b), with 75 percent crystallized within 24 hours. However, the balance of the droplets were slow to crystallize; and at the end of 7 days, droplets were still visible.

Xylene: The drops from the xylene solution when pipetted on glass acted similarly to those of benzene and broke into droplets of approximately the same size range, but crystallized more slowly as only 25 percent were crystallized after 24 hours. The crystals were of similar shape and size to those formed from the benzene solution (plate 2c).

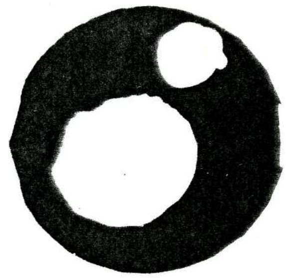
Solvesso #2: The drops on the glass broke into droplets similar to those from the benzene solution with 15 percent having crystallized at the end of 24 hours (plate 2d).

Velsicol AR-50: The drops spread over the glass surface and combined with each other to form a continuous film. Crystallization did not begin until after 48 hours when the edges of the film began forming needle-like crystals (plate 2e). These crystals continued to form until, after five days, the entire surface was covered with crystals of similar shapes.



100μ

A-ACETONE



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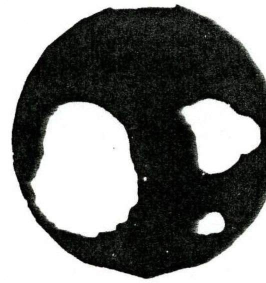
B- BENZENE



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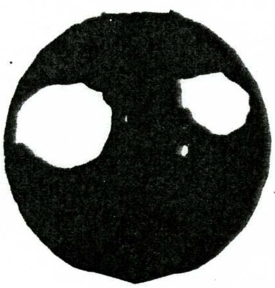
C- XYLE



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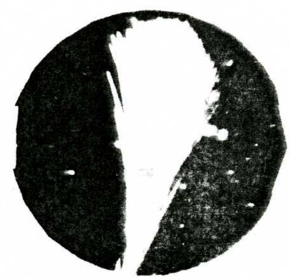
D-SOLVESSO #2

100μ

E-VELSICOL AR-50

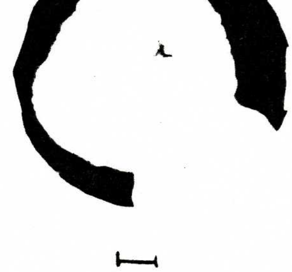


100μ

F-KEROSENE

100μ

G-KEROSENE



100μ

H-ISOPHORONE

PLATE 2

Kerosene: The drops from the kerosene solutions spread over the glass forming a continuous film. At the end of 24 hours, crystal formation was complete with two types of crystals having formed in almost equal amounts. Type A (plate 2f) were long needle-like crystals grouped together like sheaves of wheat; whereas type B (plate 2g) were shaped like a tree branch with small twigs shooting off from the main branch.

Velsicol NR-70: The drops spread into a thin film without any crystal growth visible after two weeks study.

Isophorone: The drops spread into irregular shapes with 25 percent having crystallized at the end of 24 hours. These crystals were large flat plates touching each other and forming definite lines of division (plate 2h). At the end of 3 days, all the drops had formed into the same type crystal.

Xylene-water Emulsion: The drops remained intact and began to crystallize almost immediately, the outer edge forming first. Within an hour the entire drop was completely crystallized in one crystalline mass.

Work is being continued in the study of DDT crystals from these solvents.

RODENT AND ECTOPARASITE CONTROL INVESTIGATIONS

C. M. Tarzwell[6], P. A. Woke, H. P. Nicholson, T. B. Gaines

Rodenticidal Studies

Investigations with "Rattengift"

Field tests with the sodium salt of p-dimethyl amino benzenediazo sulfonic acid were continued. Ground fresh fish baits containing 0.75 percent of this rodenticide were set out in four business establishments infested with Norway rats. The results are as follows:

1. Type establishment: Grocery store

   Degree of infestation: Moderate

   Number of baits set out: 80

   Number of baits recovered: 27

   Number of animals recovered: 1 cat

   Odor: Strong under floor

   Remarks: Damage to merchandise ceased after poisoning and no fresh rat signs were seen for 5 days. Five days after poisoning, tracks of one rat were observed in sawdust. Cups of "1080" solution were set out on the 8th day and one rat was recovered.

6/ Assigned to this branch on December 1, 1946

2. Type of establishment: Poultry abattoir

Degree of infestation: Heavy

Number of baits set out: 215

Number of baits recovered: 62

Number animals recovered: None

Odor: None

Remarks: Rats were reported to be less numerous. Thirty-two Norway rats were recovered following the use of "1080." Tracks in the dust set out after "1080" was used indicated that live rats still were present.

3. Type establishment: Poultry abattoir

Degree of infestation: Heavy

Number baits set out: 245

Number baits recovered: 10

Number animals recovered: 1 immature Norway rat

Remarks: The management reported that rats were still numerous six days after poisoning. Forty-four rats were recovered following the use of "1080" solution. Tracks in the dust patches which were put out indicated that rats were still present following the use of "1080."

4. Type establishment: Grocery store

Degree of infestation: Moderate

Number baits set out: 60

Number baits recovered: 9

Number animals recovered: 6 immature Norway rats

Odors: 2

Remarks: Damage to merchandise ceased following the use of "Rattengift." Cups of "1080" solution set out seven days following the first poisoning gave no apparent results. Tracking dust indicated the presence of not more than three rats following the use of "1080."

On the basis of these limited field tests, "Rattengift" used in a meat bait appears to give less satisfactory control of Norway rats than does 20-percent-ANTU dust. Further tests will be necessary to determine whether or not it can be used satisfactorily in other forms.

ANTU-DDT Investigations

In "Summary of Activities" No. 7, a report was made on the mortality among Norway rats exposed to 20 percent ANTU - 10 percent DDT dust by a single passage through an artificial runway two feet long which had been dusted with 10 to 15 gm. of the mixture. Although the resulting mortality to adult rats was 86 percent, that among immatures was only 30 percent.

These tests have been continued increasing the ANTU content of the dust to 50 percent. A total of 39 adult Norway rats have been exposed with a resulting mortality of 92 percent. The mortality among a group of 40 immature rats treated in the same manner was also 92 percent.

These investigations are being continued.

Studies of the Fumigant, Tritetre

Tritetre is a name given a formulation used by Dr. Gueseppe Penso in Italy for rat control. Information as to the constitutents of this fumigant are not complete, but it is believed to consist of trichloroethylene 20 percent and tetrachloroethylene 80 percent by volume. In tests which have been conducted, the above formula was used as a spray from a DeVilbiss electric sprayer. It is understood that an electric vaporizer was used in the tests in Italy, but these were not available for the present tests.

The spray was introduced through a hole into a tight box containing the rat or rats to be tested. Results of the tests indicate that in order to be effective the material must be used in concentrations considerably greater than 1 ml. per cubic foot of area. As concentrations greater than 1 ml. are probably impractical in actual use, it is concluded that the formula tested does not have much promise as a rodenticide.

Field Insecticidal Studies

Control of Rat Ectoparasites with 5 percent DDT

A series of investigations to determine the value of 5 percent DDT in pyrophyllite for the control of rat fleas, which was initiated in Columbia, S. C., during July 1946, was concluded early in November 1946. Details of these studies, through the period 6 weeks following treatment, were reported in the 7th "Summary of Activities" of this laboratory. The data contained herein is a report of this study over a period of three months, and compares results with those obtained in a similar series of investigations made with 10-percent-DDT dust in Savannah, Ga., in 1945.

Figure 1 shows curves of the normal populations of Xenopsylla cheopis, the oriental rat flea, on rats taken from check establishments during both 5 percent and 10 percent DDT investigations, and comparable curves of the same populations on rats taken in treated establishments. Each point on the curves is an index, or arithmetic mean, of the number of fleas per rat trapped from the particular group of establishments concerned. In figure 2 are shown the comparative rates of re-infestation in treated establishments expressed as percentage of the normal infestation as found in untreated establishments at the same time.

Table 13 contains detailed comparative data from both check and treated establishments in both 5 and 10 percent studies.

It should be noted that the X. cheopis populations found on rats were almost completely eliminated within approximately one week after application of both 5 and 10 percent DDT dusts. These outstanding reductions occurred consistently in the individual treated establishments. At the end of three months re-infestation had not occurred to a significant degree in either the 5 or 10 percent series as compared with the check areas. Further, there appears to be no significant difference, over a three-month period, between the results obtained by application

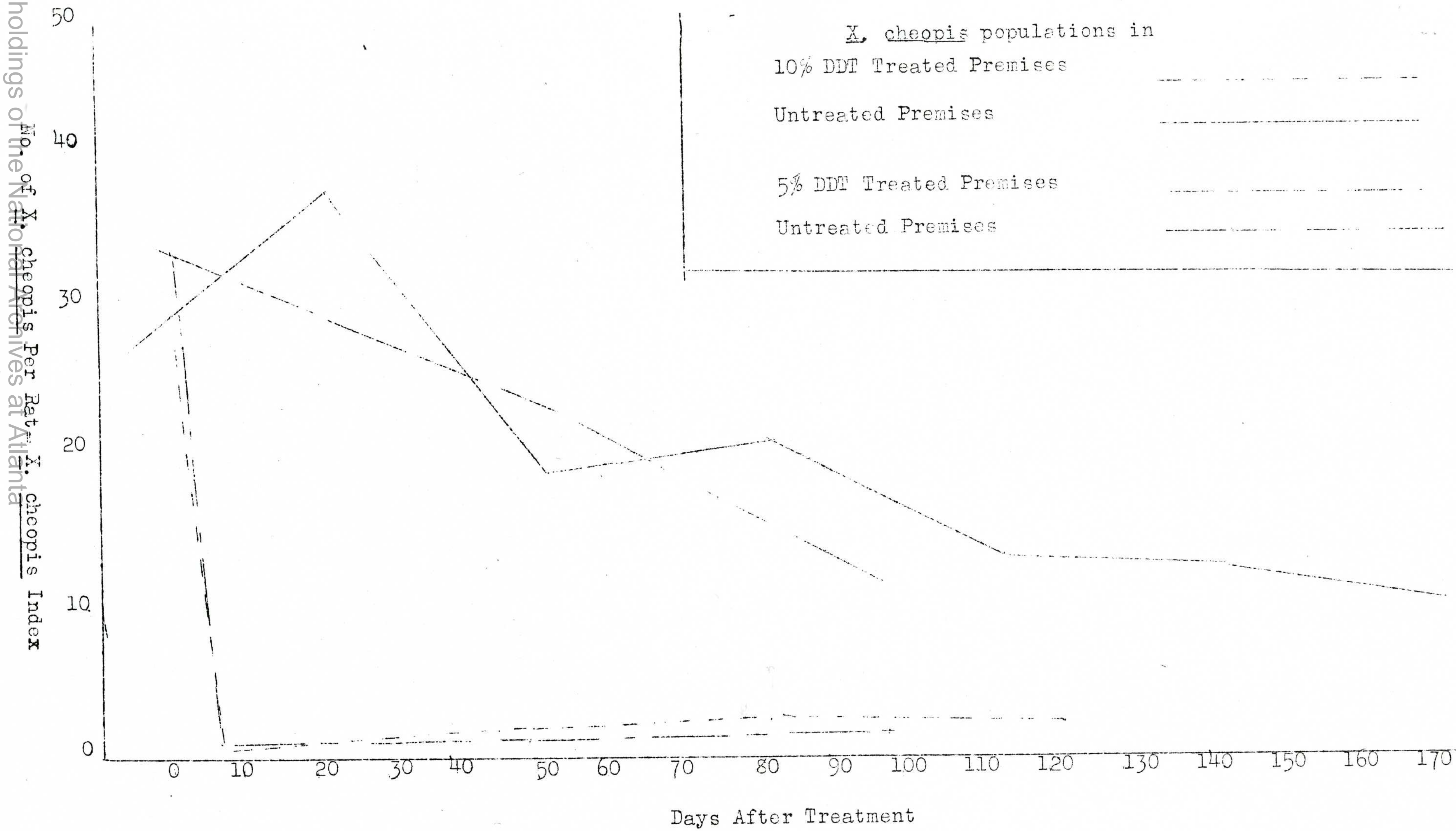


Figure 1. Comparison of 5% and 10% DDT dusts applied to control the oriental rat flea, Xenopsylla cheopis (Roth.)

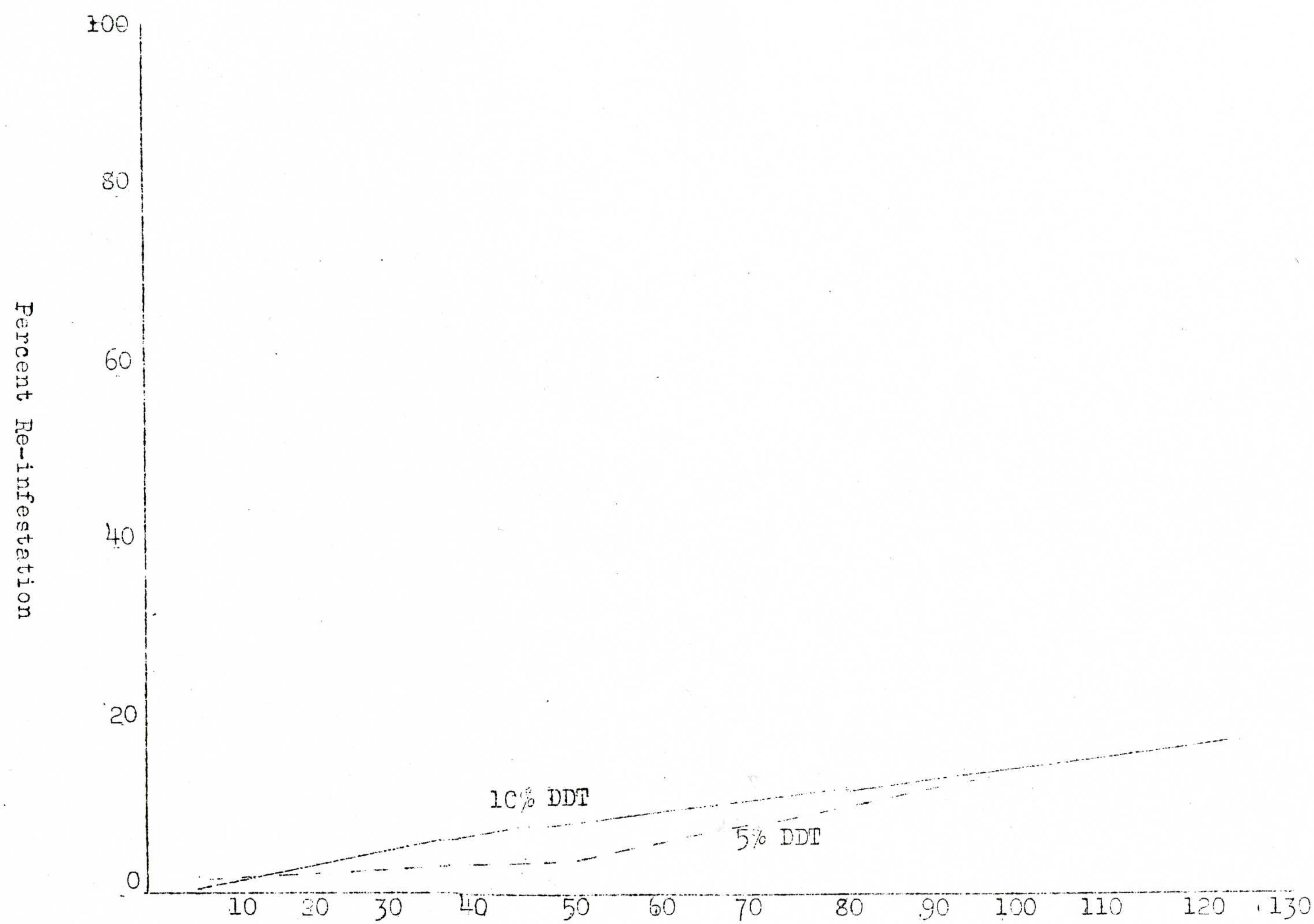


Figure 2. Comparative re-infestation by the oriental rat flea, _Xenopsylla cheopis_ (Roth.), following treatment with 5% and 10% DDT dusts.

Table 13. Comparative data on rat fleas from DDT-treated and from untreated check establishments.

a. Treated establishments

5 Percent DDT				10 Percent DDT			
Days After Treatment	Number of Rats	X. cheopis Index	Total Fleas Index	Days After Treatment	Number of Rats	X. cheopis Index	Total Fleas Index
6	52*	0.7	0.9	6	59	0.2	0.3
48	110	0.9	1.6	44	50	1.7	1.7
97	56	1.6	1.8	81	49	2.6	2.7
				121	48	2.3	2.6

*One aberrant rat with 71 X. cheopis and 2 E. gallinacea is not included in the indices. Out of twelve other rats caught from the same establishment and at the same time ten had no fleas, one had two and a third had four. The aberrant rat was probably an invader which had not yet contacted DDT dust. If counted, the indices would be 2.0 and 2.2.

b. Check establishments

5-Percent-DDT Check				10-Percent-DDT Check			
Days After Treatment	Number of Rats	X. cheopis Index	Total Fleas Index	Days After Treatment	Number of Rats	X. cheopis Index	Total Fleas Index
-2 Pretreatment	77	34.7	38.3	-6 Pretreatment	70	27.5	38.9
53	53**	23.3	26.6	21	31	38.1	38.7
98	42	11.6	17.7	51	42	19.2	19.4
				81	86	21.5	21.6
				112	72	13.5	14.1
				143	35	12.9	14.4
				173	48	10.6	11.4

**One aberrant rat with 354 X. cheopis not included in the above indices. If included, the indices would be 29.4 and 32.7.

of either 5 or 10 percent DDT dusts. This should not be construed as a recommendation of the reduced dosage, since the experiment has not yet extended over a sufficiently long period of time.

The duration of control resulting against species of fleas other than X. cheopis was not determined beyond the first posttreatment period in either the 5 or 10 percent DDT studies. The scarcity of these species in check establishments as well as in those treated did not justify comparison at the later posttreatment periods.

In the 5 percent DDT studies Echidnophaga gallinacea, the sticktight flea, was the only flea species other than X. cheopis present in numbers large enough to consider. There were 152 specimens collected from 13 rats taken in 5 establishments before treatment. Six days following treatment only seven E. gallinacea were taken from a total of 3 rats caught in 3 establishments.

In the 10 percent DDT studies approximately the same results were obtained, but a larger population of fleas other than X. cheopis were present prior to treatment. At the pretreatment trapping period 39 out of a total of 77 rats had 31 Nosopsyllus fasciatus, 462 Leptopsylla segnis, 238 Echidnophaga gallinacea, and 72 Ctenocephalides felis. Roughly a week following treatment with 10 percent DDT dust these same establishments yielded 59 rats, 3 of which, taken from different establishments, had a total of only 3 fleas other than X. cheopis. These included 2 N. fasciatus and 1 L. segnis.

Evaluation of Green-lake Pigment

Field and laboratory tests were made to determine the efficacy of using green-lake pigment with the DDT pyrophyllite formulations used for the control of rat fleas. This pgiment No. A 39895 which was submitted by Fazandee and Sperrle Inc. is designed as a safeguard to humans through the suggestive poisonous color it imparts to the DDT dusts.

Tests were made with the pigment to determine the percentage at which it should be used and a satisfactory mixing procedure, the reaction of rats to the color, its effects on the toxicity of the DDT pyrophyllite mixtures, and any detrimental effects of the pigment on treated surfaces.

It was found that green-lake pigment can be adequately dispersed throughout the DDT formulations commonly used for the control of rat fleas by mixing in a ball mill or a hand-operated barrel mixer for 15 minutes. The ball mill gives a more uniform mixture and a desirable shade of green is obtained with 1 percent of the pigment. With the hand mill, 3 percent of the pigment is required to produce a comparable shade. However, differences in cost due to the larger percentage needed for hand mixing probably would not justify the purchase of a ball mill. Greater percentages of the pigment are not recommended as the color produced might be so intense as to cause the dust to be objectionable around buildings.

The green color did not repel rats in laboratory tests and the pigment did not have any detectable effect on the toxicity of the formulation to rat fleas. Field tests with the colored dusts indicated a 97 percent reduction in the average rat flea index in treated areas. The pigment is almost insoluble in water and it does not stain wooden surfaces or adhere to them even after being wet for 2 days.

Rat-proofing Investigations

Rats which had excavated cavities and established harborage in six-inch thick insulation blocks on or soon after August 15, 1946 (reported in "Summary of Activities" No. 7), continued to use these cavities as harborage and nesting places until November 5, 1946 on which date the experiment was discontinued. The six young which were born on or about September 22 in a cavity of a cork insulation panel, were apparently normal and healthy on October 25 on which date they were removed. Eight young were born about October 22 to a pair nesting in a fibrous type of insulation. The accidental death of the mother terminated the observations.

The common rat mites Echinolaelaps echidninus and Laelaps hawaiiensis were present in large numbers in the nests of each of the two cork insulation panels and in one of the fibrous insulation panels. The cork material was dry, but the fibrous material was filthy with urine and feces. Young had been born and raised in one of the cork panels. The other two panels had been used only by mature rats. The mites were first noticed in small numbers in September, but a rapid build-up occurred during October.

These observations suggest that under usual conditions of application thick insulation panels of the types with which these experiments were made (cork and fibrous compositions) may serve as harborage and nesting places, that young may be produced and reared, at least in cork insulation, and that within these nests heavy infestations of the rat mites _Echinolaelaps echidninus_ and _Laelaps hawaiiensis_ may occur. No reason is apparent for thinking that infestations of _Liponyssus bacoti_ would not also develop under these conditions.

Laboratory Insecticide and Acaricide Investigations

Standardization of procedures for laboratory screen testing and evaluation of candidate chemicals as possible acaricides has followed the establishment during September and October of strong cultures of _Liponyssus bacoti_ and the reestablishment of cultures of _Echinolaelaps echidninus_, with the previously established culture of _Laelaps hawaiiensis_.

Twenty-five percent hydroxymethyl flavan in celite tested in open vessels against _E. echidninus_, _L. hawaiiensis_ and the flea _Xenopsylla cheopis_ was slow acting, and reduction after continuous exposures for 24 and 48 hours was generally not marked.

Benzene hexachloride (see footnote 2, page 1) in strengths of 0.5 percent to 5.0 percent gamma isomer tested in open vessels was generally quick to inactivate mites (_L. bacoti_, _E. echidninus_, and _L. hawaiiensis_). Exposures to light coatings of dust for one hour or less at temperatures about 75° F. resulted in 100 percent kills within 24 hours. Fumigant action may be strong even in open vessels, particularly with heavy deposits.

A rat dead from a heavy infestation of L. bacoti in one of the cultures, was thoroughly dusted with benzene hexachloride in a strength of 1 percent gamma isomer and held at temperatures ranging between 70° and 78° F. On examination of the combings of the rat 25 hours later it was found that 33 mites were living and approximately 800 were dead. The dust of the vessel in which the rat was held, on examination 72 hours after the application, was found to contain approximately 2600 dead mites.

Another rat dead from mite infestation was thoroughly dusted with benzene hexachloride reported to contain not less than 10 percent gamma isomer. After 20 hours at room temperature the rat was combed and examined. Over 5000 dead mites were found as contrasted with 76 living mites (see table 14).

Table 14. Mites recovered from a rat dusted with benzene hexachloride after having been killed by mites. Exposure was for 20 hours at room temperature.

	Dead Mites (approx. No.)	Living		Total
		L. bacoti	E. echidninus (contaminant of culture)	
Combings	1980	49	11	
Dust about rat	3034	11	5	
Total	5014	60	16	5090

A third rat dead from mite infestation was thoroughly dusted with a water-dispersible benzene hexachloride having a gamma-isomer content of 5 percent. This rat was held in an outside open building at current winter temperatures (about 50°-60° F.) for 44 hours, at the end of which time practically all of the 658 L. bacoti mites were alive, reviving from a dormant condition immediately upon exposure to room temperature.

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23 January 1947

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